SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, JANUARY 1938

By CHARLES M. LENNAHAN

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison. Measurements of the intensity of direct solar radiation through Schott color filters, for the determination of atmospheric turbidity and precipitable water vapor, are conducted at Washington and Blue Hill.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording Eppley thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian Silver Disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (seventy-fifth meridian time) and at noon (local mean solar time).

During February 1938 direct solar radiation intensities averaged above normal at all four stations: Washington, Madison, Lincoln, and Blue Hill.

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of an Eppley pyrheliometer recording on either a microammeter or a potentiometer.

During February 1938 all stations show a deficiency in the total solar and sky radiation for the month with the exception of Fairbanks, New Orleans, San Juan, and Friday Harbor. These four stations also had an excess of total radiation during January.

For the determination of atmospheric turbidity and precipitable water, the intensity of direct solar radiation at normal incidence is measured, with and without color filters, by a thermopile recording on a potentiometer. The publication of table 3 is temporarily suspended, during a reinvestigation of the transmission of the filters.

No polarization measurements were made at Madison due to continual snow and ice cover, nor at Washington since the recently repaired polarimeter has not yet been installed.

TABLE 1.—*Solar radiation intensities during February 1938*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Feb. 1	1.60			0.98	1.21		1.27	1.10			1.32
Feb. 4	5.36				1.16						4.57
Feb. 8	3.45	0.85	0.98	1.14	1.32						2.49
Feb. 10	6.02		.72	.89	1.10		1.12				3.81
Feb. 16	1.68				1.32		1.26				1.37
Feb. 21	2.62			1.08				1.09			3.00
Feb. 25	2.26				1.24						1.68
Means		(.85)	(.85)	1.02	1.22		1.22	(1.10)			
Departures		+.13	+.02	+.01	+.02		+.01	+.09			
MADISON, WIS.											
Feb. 14	1.52	0.98	1.11	1.28	1.47						1.07
Feb. 28	1.60	1.11	1.20	1.32	1.48						2.16
Means		(1.04)	(1.16)	(1.30)	(1.48)						
Departures		+.11	+.09	+.10	+.11						
LINCOLN, NEBR.											
Feb. 3	1.78		0.91	1.11							1.78
Feb. 5	4.95						1.32	1.19	1.03		8.48
Feb. 6	4.17	1.07	1.18	1.31	1.48		1.46	1.28	1.15	1.05	3.99
Feb. 9	2.87						1.33	1.17	1.01	.89	1.78
Feb. 12	6.50								.97	.83	10.59
Feb. 14	1.37	1.04	1.12	1.24	1.39						1.24
Feb. 18	.74		1.12	1.26	1.43						.91
Feb. 19	.79	1.04	1.15	1.29	1.47		1.51	1.35	1.21	1.10	1.52
Feb. 22	2.87						1.25	1.16			2.87
Feb. 23	2.16						1.26	1.12	.91	.77	1.96
Feb. 25	2.87				1.37				1.01		3.81
Feb. 26	4.37	1.02	1.12	1.25	1.43		1.43	1.28	1.15	1.03	4.75
Means		1.04	1.10	1.24	1.43		1.37	1.22	1.06	.97	
Departures		+.11	+.08	+.08	+.07		+.02	+.07	+.05	+.06	
BLUE HILL, MASS											
Feb. 1	1.8				1.41		1.45	1.32	1.19	1.08	1.6
Feb. 8	1.4			1.13	1.43						1.4
Feb. 10	2.8				1.40		1.40	1.16	.96		1.3
Feb. 11	.8				1.40		1.40				1.7
Feb. 12	1.3			1.05	1.30						1.0
Feb. 15	1.5				1.35		1.44				1.2
Feb. 16	1.0			1.37	1.41		1.41	1.26	1.00	.96	.8
Feb. 17	1.4			1.12	1.40						2.2
Feb. 21	1.5				1.32						1.8
Feb. 22	2.4				1.22						1.8
Feb. 26	2.1						1.30	1.11	.95		2.1
Means				1.17	1.36		1.40	1.21	1.02	(1.02)	
Departures				+.09	+.08		+.13	+.05	−.04	+.01	

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca	Newport
	Gram-calories per square centimeter																
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 29	191	120	225	93	156	176	55	103	258	267	257	187	170	491	98	103	219
Feb. 5	213	95	193	96	177	230	94	138	257	290	296	246	233	507	117	124	252
Feb. 12	210	134	208	120	176	247	139	181	293	323	280	281	238	576	135	106	268
Feb. 19	150	182	320	96	140	352	90	225	438	314	308	410	179	548	197	178	207
	Departures of daily totals from normals																
Jan. 29	−12	−65	+1	−25	+2	−22	+10	−88	−72	−67	+41	−58	−54	+18	+2	−62	.....
Feb. 5	+2	−108	−67	−39	+13	−36	+34	−71	−11	−51	+68	−26	−10	−12	+2	−54	.....
Feb. 12	−11	−88	−61	−21	+6	−41	+57	−92	+7	−21	+33	−9	+10	+18	+3	−46	.....
Feb. 19	−103	−69	+21	−81	−54	+13	−23	−26	+24	−49	+26	+71	−90	−19	+54	−34	.....
	Accumulated departures since Jan. 1																
	−1,624	−3,255	−1,155	−1,358	−196	−1,267	+777	−3,115	+56	−1,253	+553	+70	−798	+950	+455	−1,561	.....

Summary of meteorological conditions during solar observations, Blue Hill, February 1938

Date	Time from local noon	Temperature (° C.)	Vapor pressure (mm)	Wind (Beaufort)	Visibility (0–10)	Sky blue	Cloudiness and remarks
Feb. 1	2:03 a. m.	−8.4	1.8	NW 4	9	8	2 Cu, Light haze. Cloud amt. varying 2–4.
1	0:13 a. m.	−8.2	1.6	NW 4	9	9	3 Cu, Light haze. Edge of Cu nearing sun at end of observation.
8	3:32 a. m.	−8.4	1.4	NNW 4	9	9	Zero clouds. Light haze; light smoke haze N.
8	2:14 a. m.	−5.9	1.5	NNW 4	10	14	Trace Ci, light smoke haze to N.
8[1]	1:56 a. m.	−5.9	1.5	NW 2	10	14	1 Ci, moderate smoke haze to N.
8	0:07 p. m.	−2.5	1.4	NW 1	10	12	4 Ci, light smoke haze to N and NE.
8	2:27 p. m.	−.8	1.1	NW 1	10	8	5 Ci, Cs. Moderate smoke haze to N.
8[1]	2:44 p. m.	0	1.9	NW 1	10	5	Do.
10	3:43 a. m.	.8	2.3	NW 9	10	10	1 Cu, Sc.
10	0:47 a. m.	1.1	2.2	NW 8	10	12	1 Cu.
10	0:04 p. m.	1.1	1.3	N 8	10	11	Trade Cu.
10	2:16 p. m.	1.7	1.5	NNW 6	10	13	Trace Sc.
10	4:02 p. m.	.6	1.1	NW 5	10	12	Trace Cs.
11	3:05 a. m.	−12.2	1.0	NW 4	9	10	8 Ci, few thin Ci passed over sun during screening.
11	0:11 p. m.	−7.1	1.4	NNW 2	9	11	2 Ci, Dense haze to N, light haze to E.
12	3:42 a. m.	−4.9	1.0	Calm	7	10	Trace Ac.
12[1]	9:45 a. m.	−3.7	1.4	S 2	8	14	Do.
12	1:54 a. m.	−3.1	1.4	SSW 2	8	14	Trace Ac, Dense smoke haze N, light to S and W.
15	2:31 a. m.	−9.4	1.7	NNW 5	9−	7	Trace Cu, Sc. Light haze N Sc. and E.
15	0:06 p. m.	−6.7	1.2	NNW 5	10	12	Trace Ci, Cu, light haze N and E.
15	2:11 p. m.	−4.8	1.5	NW 5	10−	11	4 Ci, Cu, Frcu.
16	3:43 a. m.	−13.2	1.0	WNW 5	8	14	Zero clouds. Light haze E, S, W. Dense smoke haze to N.
16	1:58 a. m.	−11.9	1.2	NW 5	9	13	Zero clouds.
16	0:04 p. m.	−8.3	.8	NNW 5	10−	13	Do.
16	2:17 p. m.	−5.6	1.3	NNW 5	10−	10	Do.
16	4:05 p. m.	−5.6	1.3	NW 5	10−	10	Do.
17	3:44 a. m.	−9.3	1.5	NNW 3	9	11	Trace Ci, Ac. Light haze. Dense smoke haze N.
17	1:55 a. m.	−5.0	2.1	S 3	8+	11	2 Ci, Ac. Moderate haze. Dense smoke haze N.
21	3:47 a. m.	−7.9	1.4	N 5	7+	10	Trace Sc. Moderate haze. Dense smoke haze N.
21	1:46 a. m.	−6.1	1.6	N 4	7+	10	Trace Cu. Moderate haze. Dense smoke haze N.
21	0:08 p. m.	−4.8	1.8	NE 4	8+	10	Trace Cu. Light haze N. Moderate haze W.
21[1]	0:33 p. m.	−4.4	1.8	NE 4	8	10	Trace Cu. Light to moderate haze.
21[1]	1:43 p. m.	−3.9	1.5	NE 4	9	11	Trace Cu. Light haze to N
21	2:12 p. m.	−3.1	1.8	NE 4	9	11	Trace Cu. Light haze.
22	3:48 a. m.	−4.4	2.4	SSW 3	8+	10	Trace Ci. Light haze to N. Light ground fog below summit.
26	0:11 a. m.	−3.9	2.1	NW 2	8	8	Trace Ac, Cu. Light haze N, E, and W.
26	2:20 p. m.	−1.1	1.9	WNW 3	9−	10	Trace Cu. Smoke over Boston and harbor.
26	4:07 p. m.	−.3	1.5	W 3	9−	10	1 Ci, Cu.

[1] Indicates Smithsonian observation.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Mt. Wilson group No.	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot or group	Area: Total for each day	Spot count	Observatory
1938	*h m*		°	°	°				
Feb. 1	11 23	5760	−51.0	346.4	−11.0	121	.....	5	U. S. Naval.
		5753	−21.0	16.4	−6.5	54	.....	3	
		5756	−11.0	26.4	+12.5	485	.....	15	
		(1)	+26.0	63.4	+9.0	121	.....	7	
		5736	+82.0	119.4	+19.0	145	926	2	
Feb. 2	10 58	5764	−76.0	308.5	−16.0	24	.....	1	Do.
		5760	−39.5	345.0	−10.5	242	.....	4	
		5758	−8.5	16.0	−6.0	24	.....	2	
		5756	+2.0	26.5	+13.0	532	.....	16	
		(1)	+39.0	63.5	+9.0	97	969	5	
Feb. 3	16 2	5766	−80.0	288.6	−20.0	145	.....	2	Do.
		5764	−60.0	308.6	−17.0	48	.....	1	
		5760	−21.5	347.1	−10.5	291	.....	8	
		5756	+17.0	25.6	+13.0	630	.....	8	
		(1)	+60.0	68.6	+7.0	36	1,150	1	
Feb. 4	11 3	5766	−70.0	288.1	−21.0	158	.....	5	Do.
		5765	−60.0	298.1	−19.5	12	.....	1	
		5764	−49.0	309.1	−16.0	48	.....	2	
		5760	−10.5	347.6	−10.5	388	.....	18	
		5756	+28.0	26.1	+13.0	679	.....	22	
		(1)	+70.0	62	+7.0	24	1,309	1	
Feb. 5	12 5	5767	−63.0	281.4	−25.0	97	.....	6	Do.
		5766	−56.0	288.4	−20.5	97	.....	1	
		5765	−46.0	298.4	−19.5	12	.....	2	
		5764	−35.0	309.4	−17.0	48	.....	1	
		5760	+2.0	346.4	−10.5	291	.....	8	
		5756	+41.0	25.4	+13.0	436	981	15	
Feb. 6	11 16	5767	−48.0	283.7	−25.0	339	.....	29	Mt. Wilson.
		5766	−42.5	289.2	−20.0	121	.....	3	
		5765	−32.0	299.7	−18.5	12	.....	4	
		5764	−22.0	309.7	−17.0	48	.....	2	
		5763	−21.5	310.2	+22.5	48	.....	5	
		5760	+15.0	346.7	−11.0	339	.....	27	
		5768	+38.0	9.7	−18.0	48	.....	6	
		5756	+55.0	26.7	+13.5	436	1,391	24	
Feb. 7	11 4	5770	−79.0	239.6	+16.5	194	.....	2	Do.
		5767	−34.5	284.1	−25.0	824	.....	45	
		5766	−29.5	289.1	−20.5	121	.....	2	
		5765	−20.0	298.6	−19.0	48	.....	13	
		5764	−9.0	309.6	−17.0	48	.....	1	
		5763	−7.5	311.1	+21.5	24	.....	9	
		5760	+28.0	346.6	−11.0	485	.....	48	
		5768	+51.0	9.6	−18.0	36	.....	5	
		5756	+69.0	27.6	+13.5	291	.....	9	
		5769	+80.0	38.6	−15.0	12	2,083	1	
Feb. 8	11 1	5771	−76.0	229.5	+17.0	339	.....	8	U. S. Naval.
		5770	−62.5	243.0	+18.0	170	.....	2	
		5767	−21.0	284.5	−25.0	921	.....	28	
		5766	−16.5	289.0	−20.0	145	.....	3	
		5765	−7.0	298.5	−21.0	48	.....	7	
		5764	+3.0	308.5	−10.0	48	.....	2	
		5763	+6.0	311.5	+21.0	48	.....	3	
		5760	+43.0	348.5	−11.5	436	2,155	15	

[1] Not numbered.